OpenCUDA+MPI

A Framework for Heterogeneous GP-GPU Cluster Computing

Kenny Ballou

June 29, 2013

Introduction

Parallel and Distributed Computing

What is General Purpose Graphic Processing Unit (GP-GPU) Distributed Computing?

- Parallel:
    - Processing concurrently
- Distributed:
    - Processing over many computers
- GPU Computing
    - Highly Parallel Computing
- (Highly) Parallel + Distributed
    - Awesome
    - "High-Performance-Computing"

Current Problems

- "Distributed Programming" is expensive
- Specificity of Hardware
- Data
  - Distribution
  - Volume
  - Network File System (NFS)
- Fault Tolerance
- Optimizing Resources and Utilization

Goals

1. Ease Programming Expense
2. Enable / Allow Diversity in Computing Environment

Plan

- Develop several different programs/ solutions for each program
- Profile (Analyze) solutions
- Develop framework; rework solutions to use new approach; profile again
- Add Cluster / Node Configuration and Scheduling Options
- Release as Free and Open-Source Software

Salt Node Configuration

- Provisioning
    - Software
    - Configurations
    - Daemons/ Services
- Arbitrary Command Execution
    - Bring up and down nodes
    - Query load

- Complete for all nodes except for "master" or head node

Sample/ Test Programs

- 10^9 vector element-wise summation
- N-Body Simulation using particle particle, particle (adaptive) mesh (P3M) algorithm

Timing Results — Vector Summation

Method	Time (s)	Total Time (s)
CPU Only	13.7	254.13
CUDA (Single Node)	13.83	4172
MPI + CUDA (7 nodes)	10.51	(average) 3177
MPI (7 nodes)		(average) 226

Table : Computational Timing Comparison of 10^9 element wise vector summation

- **LOTS** of I/O
- Bad Example

Timing Results — N-Body Simulation
CPU Solutions

Size	User (seconds)	Sys (seconds)	Real (seconds)
2001	10.65	0.00	12.03
20000	861.46	0.00	861.72
200000	109306	18.05	109364
2 million	. . .	. . .	. . .

Timing Results — N-Body Simulation
CUDA Solutions

Size	User (s)	CPU (s)	Elapsed (s)
2001	0.68	0.48	01.25
20000	3.41	0.55	04.06
200000	31.06	1.11	32.28
2 million	347	11.93	361
20 million	115.47	120.65	13927

OpenCUDA+MPI

A Framework for Heterogeneous GP-GPU Cluster Computing

Kenny Ballou

June 29, 2013